appear to break out capriciously both in point of size and position, yet when observed perseveringly for a series of years, a recurrence of phenomena, so far at least as the total area covered by spots is concerned, becomes evident. The period required to complete this cycle is variously estimated, a little over eleven years being that most generally accepted. On Thursday last, a remarkable paper by Prof. Piazzi Smyth, Director of the Royal Observatory, Edinburgh, was read at the Royal Society, in which the results given by thermometers, buried at different depths in the earth and observed for upwards of thirty years, were tabulated and discussed. The main deduction from these observations was that the temperature of the earth, divested of the effects of transient atmospheric changes, seemed subject to a secular law. This secular variation in the earth's temperature may of course be due to secular changes going on deep in the structure of the globe itself; but it may be ascribed also, and with a far higher degree of probability, to changes in the heat-supplying power of the sun.

There is one extremely important fact connected with these changes, namely, that one of them is accomplished in $11\frac{1}{10}$ years; that is, exactly in the sun spot periods as determined by Wolf, and identical, or nearly so, with the period obtained from the Kew observations.

But the spots are only one of the known evidences of changeful activity going on in the great central luminary. The form, disposition, and dimensions of the prominences, and the distribution of the chromosphere, are visibly undergoing constant alteration. May these phenomena not also have their period of recurrence? And may not they, equally with the spot outbreaks, stand in some relation to what formerly used to be considered purely terrestrial phenomena, namely, magnetism, electricity, humidity, temperature, and rainfall? To carry the hypothesis one step further: if there is a physical relation between the solar changes and meteorological occurrences, and if the solar changes are subject to laws which cause them to recur in regular series, have we not in this secular arrangement a clue by means of which climatic variations may be studied with greatly increased effect? Is not, in short, the systematic study of solar phenomena extremely important from a meteorological point of view?

If this hypothesis, which is one daily gaining strength, be but probably sound, the careful observation of the physical phenomena of solar eclipses becomes an urgent necessity, as calculated not only to afford more just and more noble views of the constitution of the universe, but to confer on mankind the same power with respect to climatal vicissitudes, which we already possess with respect to astronomical phenomena, the power of confident prediction, which will never be ours until we have a firm grasp of the secular laws by which those vicissitudes are governed.

If these views be generally accepted, as we know they will be by those acquainted with the subject, we need not fear that anything which the knowledge and devotion of our astronomical physicists, or the power of the Government, can supply, will be wanting to effect the due observation of the Solar Eclipse of December in a manner creditable to our age and our country.

A.

ON THE BASIS OF CHEMICAL NOTATION

CHEMISTS are so much in the habit of employing what are called chemical symbols, that they are liable occasionally to forget the realities symbolised; while persons interested in the realities of chemistry, but not themselves chemists, are apt to call in question the propriety of employing any such symbols at all,—looking upon the entire system of chemical expression as an arbitrary one, having its chief warrant from authority, and not only throwing an unwarrantable gloss upon the facts, but frequently overshadowing them. That the accepted system of chemical notation is, indeed, to some extent arbitrary, and that it does throw more or less gloss upon the facts, may be admitted at once as indisputable; but nevertheless its relation to the facts is so simple and direct, and its utility as a means of illustrating and classifying the facts is so remarkable, that its justification ought not to prove a seriously difficult labour.

It being the especial business of chemists to consider every material object in relation to the kind of matter of which it is composed, they have gradually become acquainted with about sixty different kinds of matter that are unalterable in their kind by way of subtraction. The entire matter of a piece of iron, for instance, may cease to exist as iron, and, by an accretion of other matter, appear in the form of rust. But, though alterable in this way by the addition of other matter than iron to it, it is experimentally unalterable by the subtraction of other matter than iron from it. Now the sixty or more different kinds of matter having this property of unalterability by subtraction, though never declared to be in their essence elementary, are always tacitly assumed to be so; and chemical changes are accordingly interpreted in a definite way which, on this particular assumption, would appear to be the only legitimately possible way, but which, irrespective of this particular assumption, can only be regarded as one of several more or less probable ways.

Making the assumption, however, with eyes shut or open, as the case may be, chemists are able to learn, by analysis, the respective weights of the different elementary substances constituting a given weight of any compound substance. The results of the analyses are, of course, expressible in various modes; the most obvious, and, so to speak, impersonal mode, being the centesimal one—the setting forth of so many parts by weights of the respective constituents in 100 parts by weight of the particular compound. But in the case of several different compounds having one or more common constituent, the relationship of composition subsisting between the different compounds is much better brought out by taking some common constituent as a constant, and the other constituents as variable in relation thereto, rather than by taking all the constituents alike as variable.

Now, among the sixty or so elements, hydrogen is characterised by this peculiarity, that in nearly all the compounds of which it is a constituent, it exists in a smaller proportion by weight than any other constituent, while in absolutely all its compounds it exists in a smaller proportion by weight than some other constituent; so that in the compounds which it forms with but one other kind of elementary matter, its proportion by weight is always less than that of the other elementary matter with which it is combined. Even in that particular hydrogen compound, namely, marsh-gas, in which the amount of constituent hydrogen is largest, its proportion reaches only to 25 per cent., while among the many thousands of hydrogen compounds known to chemists, the following, and certain of their immediate congeners and isomers, are almost the only ones containing hydrogen to the extent of 11 per cent. and upwards :—

	Per-centage of constituent hydrogen.
Marsh-gas	25·0
Higher paraffins	14 to 20·0
Ammonia	17·6
Methylamine	16·1
Higher alcohol bases	14 to 15·5
Olefiant gas and homologues	14·3
Higher alcohols	13 to 14·0
Wood-spirit	12·5
Water	11·1

From the circumstances, then, of hydrogen forming so small a proportion by weight of the compounds it helps to constitute, its proportion may conveniently be taken as unity, and the composition by weight of the above tabulated hydrogen compounds be preferably expressed as follows :—

	Parts by weight.		
Marsh-gas . .	1	hydrogen to	3·0 carbon
Ethyl hydride	1	,,	4·0 carbon
Ammonia . .	1	,,	4·7 nitrogen
Methylamine .	1	,,	5·2 nitrogen + carbon
Ethylamine .	1	,,	5·4 nitrogen + carbon
Olefiant gas .	1	,,	6·0 carbon
Alcohol . .	1	,,	6·6 oxygen + carbon
Wood-spirit .	1	,,	7·0 oxygen + carbon
Water . . .	1	,,	8·0 oxygen

Now, while hydrogen is thus the least weighty, it is usually also the most mobile constituent of its several compounds. Accordingly, by acting on its several compounds with various reagents, it is possible to effect a removal of more or less hydrogen from them, often in the form of free hydrogen gas, more often in the form of some familiar hydrogen compound, such as water or muriatic acid. For instance, if muriatic acid itself, formic acid, ortho-phosphoric acid, and acetic acid, be each of them acted upon with either metallic sodium or caustic soda, taking care to keep the acid in excess, new compounds are produced, the composition of which in relation to that of the original acids may be expressed as follows :—

Muriatic acid and sodium chloride.

1 hydrogen + 35·5 chlorine
23 sodium + 0 hydrogen + 35·5 chlorine

Formic acid and sodium formiate.

1 hydrogen + 6 carbon + 16 oxygen
11·5 sodium + $\frac{1}{2}$ hydrogen + 6 carbon + 16 oxygen

Phosphoric acid and sodium phosphate.

1 hydrogen + 10·3 phosphorus + 21·3 oxygen
7·6 sodium + $\frac{2}{3}$ hydrogen + 10·3 phosphorus + 21·3 oxygen

Acetic acid and sodium acetate.

1 hydrogen + 6 carbon + 8 oxygen
5·7 sodium + $\frac{3}{4}$ hydrogen + 6 carbon + 8 oxygen

It is observable that the new compounds differ in composition from the original acids by a consecutively decreasing gain of sodium, and by a corresponding loss of the whole, of one-half, of one-third, and of one-fourth the original hydrogen respectively; and there is this additional point for consideration, that while in the case of formic acid and acetic acid it is not possible to obtain a compound differing from the original acid by a removal of one-third of its hydrogen, in the case of phosphoric acid it is not possible to obtain a compound differing from the original acid by a removal of one-half or one-fourth of its hydrogen. But, by further treatment of phosphoric acid with caustic soda, another compound may be obtained, differing in composition from the original acid by a removal of two-thirds, instead of one-third, the original hydrogen; while, by treatment of acetic acid with chlorine, a series of new compounds may be obtained, differing in composition from the original acid by a removal of one-fourth, and two-fourths, and three-fourths successively of the original hydrogen. Anyhow, the tendency of the hydrogen of formic acid is manifestly to break into halves, that of the hydrogen of phosphoric acid to break into thirds, and that of the hydrogen of acetic acid to break into quarters.

Now, assuming the reacting units of the four acids to contain each but a single proportion, or one part by weight of hydrogen, there seems no reason why this hydrogen should in each case break up in a specifically different manner; and, in other cases, in yet different manners, as into sixths, eighths, twelfths, and so on. But assuming the re-acting unit of formic acid to contain two proportions, that of phosphoric acid to contain three proportions, and that of acetic acid to contain four proportions of hydrogen, the reason of the different mode of breaking up becomes perfectly obvious, as shown in the following comparison with respect to composition of the original acids and their produced sodium salts; whereby it appears that a similar exchange of twenty-three parts by weight of sodium for one part by weight of hydrogen is effected in each of the four reactions.

Muriatic acid and sodium chloride.

1 hydrogen + 35·5 chlorine
23 sodium + 0 hydrogen + 35·5 chlorine

Formic acid and sodium formiate.

2 hydrogen + 12 carbon + 32 oxygen
23 sodium + 1 hydrogen + 12 carbon + 32 oxygen

Phosphoric acid and sodium phosphates.

3 hydrogen + 31 phosphorus + 64 oxygen
23 sodium + 2 hydrogen + 31 phosphorus + 64 oxygen
46 sodium + 1 hydrogen + 31 phosphorus + 64 oxygen

Acetic acid and sodium acetate.

4 hydrogen + 24 carbon + 32 oxygen
23 sodium + 3 hydrogen + 24 carbon + 32 oxygen

This, then, is the assumption actually made by chemists, and further warranted by many important considerations. For example, ammonia has the property of forming compounds with the above acids by direct combination or addition; and the respective maximum quantities of the formic, phosphoric, and acetic acids, with which a given weight of ammonia can so combine, do actually yield twice, three times, and four times respectively the particular weight of hydrogen that is yielded by the maximum quantity of muriatic acid with which that same weight of ammonia can combine. Instead, therefore, of regarding the unit weights of all hydrogen compounds as including alike a single proportion of hydrogen, chemists regard them as including 1, 2, 3, 4, ... and *x* proportions of hydrogen respectively, accordingly as their constituent hydrogen is capable of removal in the ratios $\frac{H}{\;}, \frac{H}{2}, \frac{H}{3}, \frac{H}{4}, \ldots$ and $\frac{H}{x}$, respectively. And this position, as to the relative unit weights of different chemical substances, arrived at by the above or by some other method of attack, is the gist of the whole question. Admitted, the rest follows as a matter of course: and it will hardly be arguing in a circle to adduce the simplicity of what follows as a reason for admitting the position on which it is consequent.

The relative unit weights of different hydrogen compounds being determinable in this way, certain relations of quantity subsisting among other common constituents of the different compounds become very quickly apparent, as shown in the following examples :—

Caustic potash.
1 hydrogen + 39 potassium + 16 oxygen
Formic acid.
2 hydrogen + 12 carbon + 32 oxygen
Nitric acid.
1 hydrogen + 14 nitrogen + 48 oxygen
Phosphoric acid.
3 hydrogen + 31 phosphorus + 64 oxygen

It is obvious that in the units of these different compounds, determined with respect to their constituent hydrogen, their constituent oxygen amounts to one, two, three, and four times sixteen parts by weight respectively; and it further appears that, whenever the units of different compounds differ from one another by their amounts of constituent oxygen, the increment or decrement of oxygen is always sixteen parts or some multiple of sixteen parts, as exemplified in the case of mono-potassic succinate, malate, and tartrate, for instance—

Potassium 39 + hydrogen 5 + carbon 48 + oxygen 64
,, 39 + ,, 5 + ,, 48 + ,, 80
,, 39 + ,, 5 + ,, 48 + ,, 96

Thus, from an examination of the above, and of thousands of other instances, it would appear that the proportion by weight of constituent oxygen present in the reacting unit of any chemical substance is invariably sixteen parts, or some multiple of sixteen parts; that when two or more units of chemical substance differ from one another by the weight of their constituent oxygen, the difference always amounts to sixteen parts, or some multiple of sixteen parts; and, in fact, that sixteen parts by weight of oxygen constitute the smallest proportion by weight of oxygen, relatively to one part by weight of hydrogen, that can be introduced into, or educed from, any unit of chemical substance.

Similarly it may be shown that twelve parts by weight of carbon constitute the smallest combining proportion of carbon, relatively to one part by weight of hydrogen, and to sixteen parts by weight of oxygen; and so, not only to carbon and to oxygen, but to every presumed elementary body, there may be assigned a particular number, termed its proportional number, expressing the smallest proportion by weight of the particular body, relatively to one part by weight of hydrogen, that is found to exist in any unit of chemical substance. These relative quantities of the different elements, namely, one part by weight of hydrogen, sixteen parts by weight of oxygen, twelve parts by weight of carbon, fourteen parts by weight of nitrogen, twenty-three parts by weight of sodium (natrium), thirty-nine parts by weight of potassium (kalium), &c., &c., are denoted by the initial letter or letters of the names of the respective elements; so that the following composite expressions for the previously adduced potassium salts,

Succinate $KH_5C_4O_4$
Malate $KH_5C_4O_5$
Tartrate $KH_5C_4O_6$

indicate the unit weights of the several salts to consist of once thirty-nine parts by weight of potassium, of five times one part by weight of hydrogen, of four times twelve parts by weight of carbon, and of four, five, and six times sixteen parts by weight of oxygen respectively.

To say that the relative proportions by weight of the different elements, expressed as above by the initial letters of their respective names, constitute the smallest proportions of them that are existent in and transferable to or from any unit of chemical substance, is tantamount to saying that they constitute indivisible or atomic proportions. Accordingly, the relative weights of these proportions are very commonly spoken of as atomic weights, and the proportions themselves as atomic proportions. Some most distinguished chemists maintain, indeed, that these atomic weights are really the relative weights of distinct physical particles, or atoms. Other chemists, while not denying that this may be so, do not admit that it necessarily must be so, and, when using the word "atom" at all, employ it simply as a convenient synonyme or abbreviation of the phrase "atomic combining proportion."

It is further noteworthy, that the above deduced elementary atomic weights, or smallest relative weights of different elementary matter that are found to exist in a unit of chemical substance, also constitute the relative weights of different elementary matter which are specially comparable with one another in regard to space, to diffusive movement, to heat, and to single and multiple powers of colligation and mutual replacement.

WILLIAM ODLING

THE VOYAGE OF THE NOVARA

Reise der Osterreichischen Frigatte "Novara" um die Erde, in den Jahren 1857-58-59, *unter den Befehlen des Commodore B. von Wüllerstorf-Urbair.* Anthropologische Theil. Bearbeitet von Dr. Fried. Müller. (Vienna. 1868.)

THIS important work scarcely appears to have attracted the attention it deserves, and we propose referring to a few of the more interesting facts it contains.

The object of ethnography, Dr. Müller observes, is not to regard man as an individual, but as a member of a family, and hence to consider him by such light as can be gained from the investigation of his speech, his thoughts, his feelings, and his entire mode of living. He thinks the classification of the different races of man in accordance with the colour of the skin and the characters of the hair, extremely unsatisfactory, though adopted by many of the best anthropologists of modern times, as Linnæus, Blumenbach, Cuvier, Pickering, &c., nor less so the method